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ASSESSMENT OF CRISIS PREPAREDNESS RESOURCING TO STRESS TESTS

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Research article

Abstract: Crisis preparedness of territorial units, as well as individual elements of their safety systems, can be verified in different ways. In the Czech Republic screening exercises are often used for these purposes. Testing exercises should take place in conditions as similar as possible to the real case scenarios. However, this is often not possible for different reasons (e.g. considerable costs associated to practicing actions). One option is the use of stress tests that are presently used (e.g. nuclear safety). The aim of this article is to highlight and discuss this issue and outline the possible approach to reliable solution.

Keywords: Stress test, crisis preparedness, territory, assessments of safety situation, risk.

Introduction

Legislation, methodologies and expert texts often have some terminological uncertainties in terms of "extraordinary event preparedness" and "preparedness for emergencies, or emergency or crisis preparedness respectively.

The preparation can be explained as an essential feature, condition suitable for the realization, use of something; get ready; prepare.

Preparedness is meant by the alert status and the capabilities of human, material and other resources achieved as a result of pre-adopted measures, enabling them to ensure an effective and rapid response to an extraordinary event and a crisis situation with minimization of the consequences. Territory preparedness can be expressed as the availability and quality of forces and resources of Integrated rescue systems components and resources of civil protection to carry out rescue and disposal work and to ensure measures for the civil protection. Readiness is a measure of risk reduction because higher readiness can reduce the consequences. (Jaroš et al., 2017)

It is therefore acceptable to state that the preparation of any subject or object will achieve a certain level of (state) preparedness. Preparedness is the result of preparation. (Adamec, 2008)

Emergency and crisis preparedness for extraordinary event is taken as the ability of a territorial unit to face safety threats by non-military measures. Closer specified below.

Material and methods

For assessment of crisis preparedness in the territory are used: statistics of extraordinary events over a given period of time on a given territory, verification and tactical exercises, control activities, simulations of specific events or situations in the territory and stress tests. For the purposes of the article, stress test method for the assessment of crisis preparedness in the territory was selected. The methods of analysis and synthesis were used as an integral part of solved problems.

Crisis preparedness in the Czech republic

The Czech legal order states that verification of emergency preparedness (Act. No. 239/2000) crisis preparedness (Act. No. 240/2000), hereinafter referred to as "safety preparedness", shall be exercised. Safety preparedness in the Czech Republic is verified, as amended by the (Act. No. 240/2000) by control activities or screening exercise (Act. No. 239/2000). Another option is to

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monitor trends in extraordinary event statistics and use of stress tests.

Control activity is required by law to execute crisis management authorities at all levels of state administration. At the lowest level of the state administration, the municipality, the control activities is managed by a fire brigade of the region in cooperation with the secretary authority of the municipality with extended competence. The next level of state administration is the municipality with extended competence. The control is managed by the fire brigade of the region in cooperation with the regional authority, At the regional authorities is control activities led by Ministry of the Interior. The fire brigade of the region is verified by General Directorate of Fire Rescue Service of the Czech Republic.

Monitoring trend developments in extraordinary event statistics is a frequently used method for obtaining information on the situation in the territorial system. It is based on the recording of selected indicators linked to extraordinary events in the territorial system and their year-to-year comparison, respectively tracking a multi-year trend. Depending on year-on-year changes, long-term trends, then the level of preparedness of the territorial system in the monitored area can be derived.

Information about screening exercise and stress test will be describe in next text.

Generally, we understand the safety preparedness of the society's ability to face safety threats. (Adamec, 2008; Adamec, 2011; Boguska et al., 2014)

Verification of safety preparedness is a very specialized issue itself. We move in an environment characterized by a dual approach:

- an administrative (official) tasked with monitoring the requirements defined by the law,
- non-administrative (expert), based on modeling and simulation. (Adamec, 2008)

In administrative practice, control activities are most often used outside the exercise. The legal order determines what measures are to be adopted, which documents are to be processed, what other obligations are to be met. Some of these obligations are regulated by standards or methodologies, so their performance can be "easily" evaluated. Consideration of other matters is on the capabilities of the control authority.

Verification of the safety preparedness of territorial units, respectively their components, the screening exercises (Vackova et al., 2016) is a very challenging issue. Both in terms of time, but especially economically. The key point here is that the screening exercise takes place under realistic conditions, respectively conditions very close to real. But this is often difficult to realize.

The new possibilities for verification of safety preparedness offer the use of an expert approach, ie. modeling the safety situation in the territory and simulation of the stressful behaviour of the territorial unit, respectively its safety system in response to the extraordinary events.

Exercise of stress tests is currently a frequent testing process in various areas of safety - nuclear power safety, cyber security, banking sector security. It is therefore a question of how such a mechanism can be implemented in the context of the verification and assessment of the safety preparedness of the territorial units, or their components?

Safety model of the territory

The territorial unit (municipality, administrative district of the municipality with extended competence, region) can, with some simplification, be seen as a system - a territorial system. (Malerova et al., 2015; Malerova, 2013)

The territorial system is internally formed by the structure of elements (people, infrastructure, natural environment) and the links between them (economic, energy, financial, cultural and social). Each territorial unit is linked to its surroundings (transport, energy, telecommunications, finances, pipelines, production, etc.) with different connections that affect it. Territorial unit and its surroundings change in time - it develops.

The functioning of a territorial unit and its sustainable development must take place while maintaining state-protected interests (Constitutional act. No. 110/1998). Thus, if the safety of the territorial unit is guaranteed, respectively the safety situation in the territory will be considered acceptable.

Generally speaking, the term "situation" means a plot in a certain space and time (Spelling interpreter - online 2017). The safety situation in a territory is understood as a plot in a territory that is characterized by a set within the territory of the objectively existing elements and the links between them that can either contribute or prevent the occurrence of extraordinary events and also define their possible extent and consequences. (Malerova et al., 2015; Malerova, 2013)

With some simplification, protected interests in the territory can be tracked in the following categories:

- people,
- infrastructure,

- society (intangible assets - safety, politics, public administration, culture, ...) and
- environment.

This reflection does not conflict with foreign approaches (Methods for Risikoanalyse in Bevölkerungsschutz, 2010; Method of zoning for Katastrophen and Notlagen für die Schweiz, 2017) or our practice (Threat analysis for the Czech Republic, 2016). This allows for the mechanism of protected interests and simplified safety features of the territory:

- territory threats to extraordinary events,
- vulnerability of the territory,
- preparedness of the Territory for extraordinary events. (Malerova et al., 2015; Malerova, 2013)

to compile the Simplified Territorial Safety Model - see Fig. 1.

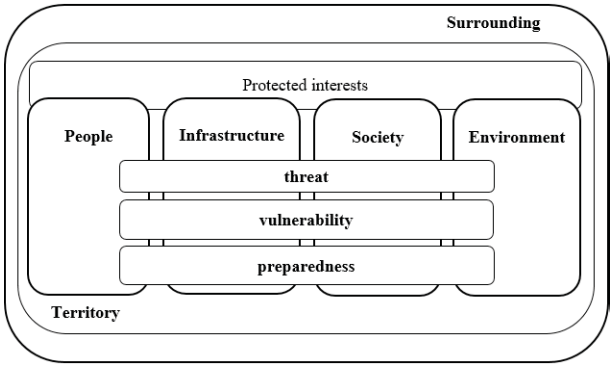

Fig. 1 Simplified Territory Safety Model - modified according to (Malerova et al., 2015)

Threat to territories by extraordinary events is intended to identify hazards (natural, anthropogenic) within the territory, to recognize the significance of possible hazards in the territory that could lead to impacts on protected interests, or their initiation may cause loss of life, human health, infrastructure, property, with regard to their frequency and intensity. (Malerova, 2013)

Determining of the vulnerability is intended to assess the availability (vulnerability) of the threat investigation. This includes various aspects, such as the potential damage that an event may cause, and may not be material in nature. For example, damage to human health, the loss of cultural property or the loss of functionality in the life necessary to provide infrastructure are perceived. (Malerova, 2013)

Preparedness has two important components - responsiveness and recovery capability related to emergency response in the event of an extraordinary events The immediate reaction is to keep the functionality of the risk element and restore the functionality as quickly as possible. (Malerova, 2013)

Preparedness of the territory for extraordinary events - safety preparedness of the territory, We understand the capacity of the territorial unit, respectively its safety system:

- recognize the possibility of creation of extraordinary events,
- prevent their creation,
- mitigate their consequences,
- to maintain the capacity of human, material and other resources for disposal,
- to create conditions for the restore of the area affected by the consequences of an extraordinary event. (Adamec, 2008; Adamec, 2011)

The presented safety model of the territory is the basis for building a stress test mechanism. The scope of the contribution does not allow for further details.

Stress tests

Most stress test definitions agree that it is a test in which the behaviour of the test system is measured in a simulated increase in its load above the normal (ordinary, projected) conditions until a functional error occurs or the response of the test system exceeds a certain limits.

On a general level, stress tests are required to define performance parameters of the test system, specific processes / processes used in the system, and to assemble a stress test scenario.

The performance parameters of the test system (subsystem) are a list of predefined, significant technical and operational data about the tested system. It can be eg the number of simultaneous interventions of the components of the rescue system in the territory, the amount of available resources, etc.

Specific procedures characterize processes that ensure the system runs to achieve declared operating parameters in its various configurations, e.g. processes in the crisis staff.

The stress test scenario determines the strain of the test system in a different way, as described by performance parameters and specific procedures.

Performance parameters and specific procedures essentially characterize the normal operation of the test system. The stress test scenario represents

the input of nonstandard requirements - stress - a system response measurement area. (Uniform rules for the Organization of the Crisis Staff of the Region, 2011), (Instruction of the General Director of the Fire Rescue Service of the Czech Republic, 2009), (Principles for the preparation and implementation of exercises by the crisis management body of the Czech Republic, 2005)

Some rules must be observed when designing stress tests. The stress tests should be repeatable, they should be based on the concurrency of several activities in the system and the randomness of the arrival of system requirements. Last but not least, the scope of testing and the method of assessment need to be determined.

Taking into account the above, using the stress tests to verify the safety preparedness of the territorial units or their individual components can be derived from the following concept.

The tested territorial unit has its safety features (protected interests, damage indicators). The territorial unit has its own territorial safety system, which has defined response capabilities. The response of the safety system takes place according to defined rules. For a normal extraordinary event, the safety system reacts by default according to the alarm plan. An extraordinary event of a significant scale, eg associated with the declaration of a crisis situation, represents a stressful situation for the territorial unit.

The achieved level of safety preparedness can be determined, for example, on the basis of a balance of resources for response and the influence of time-space deployment of resources. (Odin, Papenfuss, 2014; Pejcoch, 2016; Risikoanalyse im Bevölkerungsschutz - Ein Stresstest für die Allgemeine Gefahrenabwehr und den Katastrophenschutz, 2015) The accuracy of the evaluation result will be affected by whether a static or dynamic draft of the stress test is selected.

A static stress test uses a checklist, a workshop, such as the Delphi method, and so on to obtain a score for assessing the level of safety preparedness.

When conducting dynamic stress tests, verification and assessment of safety preparedness is done by dynamically simulating space-time balance of resource.

Concept of total land test

The basis for establishing a stress test of the safety preparedness of a territory can be the analysis of safety risks in a territory that will be appropriately modified. Changes in risk analysis will give an initial overview of potential risks in the territory, taking into account the impact on the protected interests of the individual risks monitored and the needs of the resources earmarked for the response and their performance parameters. (Methods for Risikoanalyse in Bevölkerungsschutz, 2010; Method of zoning for Katastrophen and Notlagen für die Schweiz, 2017; Threat analysis for the Czech Republic, 2016)

The source of the data needed to compile and carry out the stress test can be, for example, safety documentation - emergency plan of the region, external emergency plans, crisis plan of the region, but also various targeted investigations, etc.

Several phase mechanisms can be used to organize and manage stress tests - see Fig. 2.

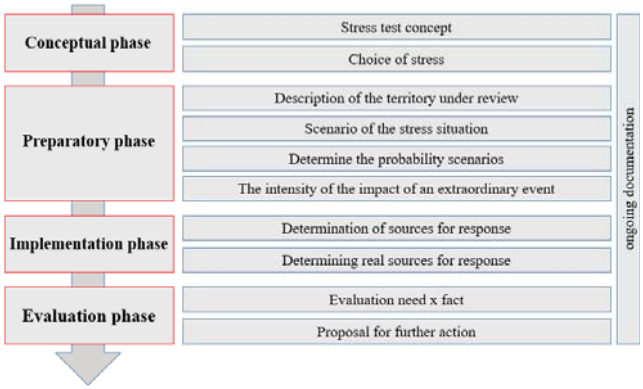

Fig. 2 Possible organization and control of the stress test (Adamec, Malerova, 2016)

When compiling a stress test, it is very important how we prepare a scenario of the stressful situation and the manifestations of its intensity (damage) in the investigated area. The following structure can be used to describe the stress situation:

- type of stress,
- instead of occurrence of an extraordinary event and its spatial delimitation,
- intensity of an extraordinary event (extent of damage),
- time of occurrence and duration of an extraordinary event,
- time course of an extraordinary event,
- available time for warning of an extraordinary event,
- reference extraordinary event and
- more information.

In describing the manifestations of stress intensity in the area, categorization according to the area of protected interests can be used, see Fig. 1, ie people, infrastructure, society, environment.

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For each category of protected interests, it is necessary to define impact indicator of an extraordinary event (damage). Using the knowledge (Methods for Risikoanalyse in Bevölkerungsschutz, 2010; Method of zoning for Katastrophen and Notlagen für die Schweiz, 2017; Threat analysis for the Czech Republic, 2016), it is possible to assemble impact indicators, for example in the following range - see Tab. 1.

Tab. 1 Example of protected interests - simplified (Adamec, Malerova, 2016)

Protected interests	Impact indicator
People	Dead
	Injury
	Diseased
	Help needed over a duration of more than 14 days
	Help needed up to 14 days
Infrastructure	Public sector
	Private sector
	Households
	Essential services
Society	Impact on safety and public order
	Political consequences
	Psychological consequences
	Damage to cultural property
Environment	Damage to protected territory
	Damage to surface water
	Damage to groundwater
	Damage to agricultural areas

Individual impact indicators can be further specified. E.g. injuries can be very badly injured, severely injured, slightly injured, no chance of survival, otherwise injured, eg mental disorder. For patients, we can distinguish patients who require ambulatory treatment, institutional treatment, intensive medical care, or special care with regard to a particular disease (eg exotic diseases).

The practical application of a static stress test is possible, for example, using a spreadsheet in Excel. The frame process illustrates Fig. 3.

Responding to the impact of a stress-related extraordinary event in the area requires the deployment of appropriate resources (resources needed). The Territorial Safety System has dedicated resources for response (real resources).

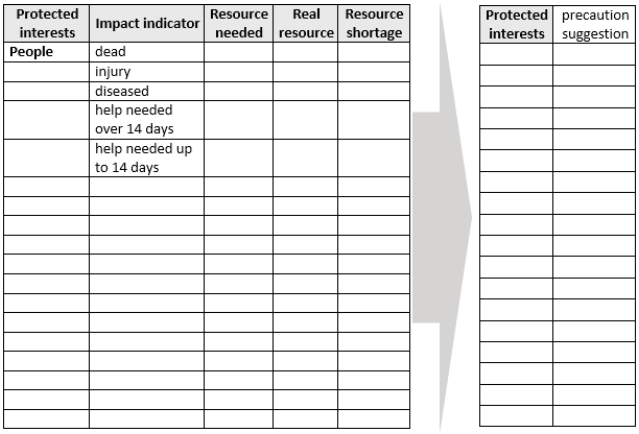

Fig. 3 Example of a frame procedure for a static stress test (Adamec, Malerova, 2016)

By comparing the resources needed for individual impact indicators with actual resources, we will get a basic overview of whether or not resources are rising or missing.

By increasing the intensity of the stress situation in the territory, ie a variation in the demand for resources for response, the result of the balance of resources changes.

The output of the balance of resources in assessing the area's safety preparedness is the list of the deficit of the sources according to the individual impact indicators. The results of the evaluation will explore how to eliminate the deficit. So, how do you make sure that resources that require partial impact are really available.

It has to be mentioned that the biggest problem at present is to express how high the deficit of resources can be considered sufficient, conditionally sufficient or insufficient, and to derive the level of safety preparedness of the object under consideration. Here we are missing a metric.

Results

This article presents an interesting perspective that could be the inspiration for further research. Stress tests should be a new source for assessing crisis preparedness in the territory and a new approach to existing controls and verification exercises.

Conclusion

The text draws attention to the fact that there are other approaches to verifying the safety preparedness of territorial units, their safety systems and their individual components.

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The presented solution approaches the use of stress tests on the principle of resource balance for response. This is a labor-intensive but increasingly cheaper mechanism than a view of the territory devastated by the impact of an extraordinary event.

We believe that in the future this may be an interesting approach to addressing the issue of verifying the safety preparedness of territorial units. And here we would like to forego that at Faculty of safety engineering, we are working to give the present approach a methodical framework.

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